Research
FOR FARMERS

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Abundant Forage on Solonetz Soil

CANADA DEPARTMENT OF AGRICULTURE

Research FOR FARMERS

CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

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NOTES AND COMMENTS

Can resistance to Verticillium wilt be bred into accepted and familiar commercial tomato varieties? L. G. Denby in his article, 'Breeding Tomatoes at Summerland' (p. 3), mentions that he and G. E. Woolliams, working together as a plant-pathologist-breeder team at the CDA Research Station, Summerland, B.C., have succeeded in developing Verticillium-resistant strains of 45 tomato varieties. These are now available and are being widely used by plant breeders in Canada, the United States, and Europe. But this is only a sidelight on the main story which describes the extent of intensive testing given Selection 59-34, how they crossed it to get further improvement in another new variety they named Summerdawn, and now look to the latter's progeny for a less demanding variety that will assure wider grower acceptance... J. Laliberte (p. 4), vegetable specialist with the Experimental Farm, L'Assomption, Que., writing in French, discusses another aspect of tomato work, namely varieties that are suitable for mechanical harvesting.

* * * *

If you have been wondering how successful hydrogen phosphide has been as a tablet-type grain fumigant, E. A. R. Liscombe (p. 6) believes that Phostoxin will be a valuable addition to the list of effective fumigants for the control of insects in stored grain. These tablets, he explains, consist of aluminum phosphide plus ammonium carbamate, and, on exposure to moisture decompose to liberate phosphine, ammonia and carbon dioxide, leaving a residue of aluminum hydroxide. The compressed tablets must remain in the grain bulk for 4 hours at the level of moisture found in stored grain before decomposition begins. At that time, a carbide-like odor of phosphine becomes noticeable. Mr. Liscombe points out that their ease of application and the delayed action lessens the danger to fumigation crews.

* * * *

In our center-spread, J. W. Morrison introduces you to the prairie apple varieties, Carroll and Garland, recently released by the Experimental Farm, Morden, Man. . . . E. R. Kerber (p. 10) does some detective work on wheat at Winnipeg and reveals a new approach is being investigated to determine characteristics. . . . On p. 12, C. R. MacLellan gives an example of how integrated insect pest control has been successfully applied to the codling moth in Nova Scotia. "Natural control and control by chemical means are not necessarily alternative methods," he states, "but with adequate understanding they may be integrated to supplement one another."

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Contributians should be addressed ta the Secretary, Editarial Baard, Infarmatian Division, Canada Department of Agriculture, Ottawa.

Cover Photo: **Summerland Research Station's latest tomato discovery, Summerdawn, has been introduced to B.C. growers on a limited trial. While it outranks competitors on uniformity, earliness, smoothness, and yields over 20 tons per acre, researchers hope its progeny will be less demanding.** **(See story p. 3.)**

Above: **Tomato breeding plots at Summerland Research Station:** *Inset:* **Summerdawn, despite its high potential, is exceptionally demanding but researchers hope continued cross-breeding will overcome this factor.** *Right:* **Author (left) discusses tomato breeding project with plant pathologist G. E. Woolliams.**

Breeding Tomatoes at Summerland

L. G. Denby

An intensive tomato breeding program has been under way for the past eight years at the CDA Research Station at Summerland, B.C. to develop varieties that are specifically adapted to Okanagan needs and growing conditions.

In one phase of our program, we have concentrated on developing disease-resistant varieties; in another, on breeding entirely new, earlier and more productive tomatoes of higher quality than those presently being grown in this area.

Verticillium wilt is a problem in most tomato fields in the Okanagan. It reduces yields and adversely affects quality. And it can't be controlled by spraying because it harbours in the soil. The use of resistant varieties is the most practical solution to the problem.

Could resistance to Verticillium wilt be bred into accepted and familiar commercial varieties? The author and G. E. Woolliams, working together as a plant-pathologist-breeder team, have succeeded in developing Verticillium-resistant strains of 45 tomato varieties. These are now available and are being widely used by plant breeders in Canada, the United States, and Europe.

The pollen parent in all crosses was the variety Loran Blood, one of the few suitable sources of genetic resistance to Verticillium available at the time. The seed parents were selected on the basis of yield performance, plant characteristics and fruit quality as determined by replicated trials conducted in the Okanagan Valley over a period of many years. To date, many crosses have been made and hundreds of selections have been closely studied and evaluated.

The earliest and most productive

Concluded on page 5

The author is head of the Vegetables and Ornamentals Section, CDA Research Station, Summerland, B.C.

Variétés de tomates pour la cueillette mécanique

J. Laliberté

SELON un rapport publié en 1954 par le Ministère de l'Agriculture de l'Ontario, la cueillette des tomates pour fins industrielles représente à elle seule 67 pour cent du coût total de la main-d'œuvre requise pour cette culture. La mécanisation de la cueillette des tomates offre donc la possibilité d'une économie substantielle et d'une réduction importante du coût de production.

Les progrès réalisés tant dans le domaine des variétés de tomates naines que dans celui de la mécanisation de la cueillette nous ont incités, à la Ferme expérimentale de L'Assomption, à entreprendre en 1960 des essais de variétés dont le type convenait à la cueillette mécanique.

En plus des qualités propres à la mise en conserve: telles la forte coloration rouge des fruits et la richesse en matières solides, la tomate adaptée à la cueillette mécanique doit posséder en plus les caractères d'une maturité concentrée, d'un rendement élevé et d'une bonne résistance au fendillement.

En effet, ce nouveau mode de cueillette nécessite l'arrachage des plants et par conséquent une cueillette unique où le rendement en fruits mûrs dépend du pourcentage de fruits rouges à l'époque de la cueillette. Les variétés naines et à croissance déterminée sont particulièrement avantageuses à cet égard en raison du rapprochement des grappes à fruits sur la tige et du temps plus court entre la nouaison des fleurs des différentes grappes. Les variétés naines ou à croissance déterminée permettent une plantation plus rapprochée et par conséquent un rendement plus élevé. Malgré toutes les précautions prises lors de la récolte, les fruits seront projetés les uns sur les autres et pour conserver leur qualité ils devront être plus résistants au fendillement. Enfin, notre courte saison de production oblige le producteur à utiliser des variétés hâtives qui mûriront avant la mi-septembre.

Depuis 1960, quelque 67 variétés, hybrides et lignées à croissance déterminée, semi-déterminée ou naine de même que 9 variétés à croissance indéterminée ont été mises à l'essai et soumises à une récolte mécanique simulée, soit à une récolte unique effectuée lorsqu'une moyenne de 1 à 2 fruits par plant devenaient trop mûrs. Les variétés à croissance déterminée les plus remarquables en essai d'observation ont été la variété C-52 de Libby, McNeill and Libby, la sélection 59-60 de G. Tait du Ministère de l'Agriculture du Québec, la Early Boy et la 0.57-G_{f1} cette dernière provenant de l'Institut de Recherches en génétique du Ministère fédéral de l'Agriculture à Ottawa.

Parmi les variétés se rapprochant le plus des exigences déterminées pour la cueillette mécanique et la conserve, les variétés Venture (11-1-12-B1), Gem, Rideau (Ott. to-28), 0.56-B5-A1, H-562, Red Cloud et Dessert R ont été mises dans un essai avancé en 1962 pour une étude plus précise de leur rendement.

Aucune différence significative n'a été enregistrée dans le rende-

Au-dessus: **A remarquer la profondeur du fruit et de la cavité du pédoncule superficiel.**

En-dessous: **Variété Venture—Fruit plat à chair épaisse.**

M. Laliberté de la Ferme expérimentale de l'Assomption, Qué., est spécialisé dans les recherches sur les légumes.

ment entre ces sept variétés. Les rendements obtenus s'échelonnaient de 20.9 tonnes pour la variété Venture à 13.3 tonnes à l'acre pour la variété Dessert R. La variété Venture récemment nommée par la Station horticole provinciale de Vineland, Ontario a été remarquable par son haut pourcentage de fruits mûrs, soit 57 pour cent en 1962 et dont la moyenne des trois dernières années était de 75 pour cent. Il est à noter toutefois que cette classification était basée sur l'apparence extérieure mais que la chair était mieux colorée dans la Red Cloud.

La variété Venture (11-1-12-B1) produit des fruits d'un poids moyen de 0.32 livre, uniformes, aplatis, d'une bonne coloration externe; sa chair est épaisse mais relativement pâle.

La variété Red Cloud porte des fruits dont le poids moyen est de 0.35 livre, uniformes, légèrement aplatis, bien colorés tant à l'intérieur qu'à l'extérieur mais à chair moins épaisse que celle de Venture.

Variétés	Jours (à 50°F.)	Dates moyennes de récolte
Red Cloud	1514	7 sept.
H-562	1571	11 sept.
Gem	1582	13 sept.
Venture (11-1-12-B1)	1584	14 sept.
Dessert R	1618	16 sept.
Rideau (Ott. to-28)	1618	17 sept.
0.56-B5-A1	1646	19 sept.

La variété Red Cloud ressemble à la variété standard Fireball quant à sa grosseur et à sa coloration interne mais elle est moins susceptible au fendillement, sa peau est colorée, la cavité du pédoncule y est moins profonde et sa maturité est beaucoup plus concentrée.

Afin de connaître la possibilité de récupérer les fruits tournant au rouge, ceux-ci ont été entreposés dans une chambre à température non contrôlée mais variant de 65 à 70°F. Le poids des fruits reclassifiés n° 1 après une semaine d'entreposage se situait entre 5.8 tonnes pour Red Cloud et 2.7 tonnes à l'acre pour la lignée 0.56-B5-A1.

Un calcul des unités thermiques basées sur le minimum de 50°F. qui ont été requises par chaque variété à partir de la plantation au champ, a donné comme moyenne triennale les résultats indiqués dans le tableau précédent.

En conclusion de toutes ces données et des observations aux champs, les variétés les plus prometteuses actuellement pour la cueillette mécanique au Québec sont par ordre décroissant comme suit: Red Cloud, Venture, H-562, Dessert R, 0.56-B5-A1, Gem et Rideau. La moyenne des rendements indique également qu'il est possible d'obtenir dans la région de Montréal une production rentable pourvu que les variétés ci-haut mentionnées soient plantées en sol approprié, bien fertilisées, protégées adéquatement contre les maladies et récoltées au moment le plus opportun.

Breeding Tomatoes at Summerland . . . *from p. 3*

line so far developed has been subjected to extensive grower trial under the number 59-34. It is a dwarf variety type. During the 1961 season, in close cooperation with E. M. King of the B.C. Department of Agriculture, approximately 70 acres, nearly 10% of the total acreage grown in the Valley, were planted to 59-34. Commercial trial plantings were established in the Cawston, Osoyoos, Oliver, Summerland, Westbank, Kelowna, Vernon, Kamloops, Walhachin, Lillooet and Spences Bridge districts. Performance of the variety—and resultant grower reactions—varied widely between districts and to a lesser extent within districts. Generally, we found that 59-34 performed very satisfactorily on all but the very light, sandy soils where the warm dry season, poor nutrition and lack of moisture appeared to reduce vigor, foilage cover and tonnage. In the Cawston and Osoyoos districts in particular, but to some extent on the lighter soils in the Vernon area as well, high cullage was encountered as a result of severe cat-facing or deformation of the blossom scar. This problem of limited adaptation even within a region is not unusual with tomatoes.

We subjected selection 59-34 to continued purification and intensive testing at Summerland and have been successful in developing a more uniform, much earlier and even more productive line with consistently smoother fruits. We have introduced this variety to growers and to home gardeners for limited trial only, under the name "Summerdawn". Its performance, under ideal conditions, has come up to expectations, with many growers reporting yields of well over 20 tons per acre.

As a result of the grower trials, the value of which simply cannot be overstated, we have found ample evidence to indicate that dwarf varieties like 59-34 and Summerdawn, with a high and concentrated yield potential, are likely to require a higher nutrient level than those varieties heretofore grown. We noted in 1961, for example, that 59-34 frequently evidenced marked boron deficiency when Fireball, grown immediately adjacent to it, showed few if any symptoms. In this connection, Dr. J. S. Matthews, Summerland Research Station, is investigating the effects of nutrient levels on the yield and quality of these and similar dwarf varieties.

Indications to date are that despite its high potential, Summerdawn is exceptionally demanding. Apparently, in order to do well, this variety has to be treated more carefully than many growers would like. To try and overcome this problem, we have already crossed Summerdawn with other varieties that have a comparative disregard for mistreatment. The progeny may or may not have the high potential of Summerdawn, but we believe it will be more easily grown and thus assured of wider grower acceptance.

The Summerland tomato breeding program is continuing. Tomato varieties can be improved and we are considering various new ways to achieve improvement. Market demands have to be met as well as competition from other areas.

Method used to probe Phostoxin tablets into a grain bulk. *Inset:* Tablets are packaged 30 to a tube.

Recently Registered . . .

Hydrogen Phosphide in *Tablet Form* as a Grain Fumigant

E. A. R. Liscombe

FUMIGATION is one of the more effective ways of controlling insects in stored grain. Because large bulks must sometimes be treated, and as some of the important stored grain pests live within the kernels, the toxicant must be capable of complete penetration for effective insect control. In studies at Winnipeg on the effectiveness of grain fumigants and environmental conditions that alter their effectiveness, the CDA Research Station's fumigation section has been giving attention to hydrogen phosphide in tablet form.

Over the years a number of liquid fumigants have been developed, some of which are highly effective and in current use. Most of these products are called large volume fumigants and require several gallons per 1000 bushels of grain for effective insect control. To treat large grain bulks by this method usually involves higher labor costs and the need for pumps, hoses and the safety of fumigation personnel. Wanted was a fumigant which could be applied more cheaply, be less hazardous, but equally effective in killing insects.

Hydrogen phosphide, more commonly known as Phosphine, has been used in stored product fumigation for many years, but is dangerous because of its extreme volatility. Recently, a process was developed in Germany whereby compressed, paraffin-coated tablets of this compound that, when dry, are relatively safe to handle and when decomposed by moisture, release phosphine gas. This product, Phostoxin, is now being used in many foreign countries and has recently been registered for sale in Canada and the United States.

Phostoxin tablets consist of aluminum phosphide plus ammonium carbamate, and, on exposure to moisture decompose to liberate phosphine, ammonia and carbon dioxide, leaving a residue of aluminum hydroxide. The compressed tablets must remain in the grain bulk for 4 hours at the level of moisture found in stored grain before decomposition begins. At that time, a carbide-like odor of phosphine becomes noticeable. Their ease of application reduces labor costs and the delayed action lessens the danger to fumigation crews.

Each tablet is $\frac{4}{5}$" in diameter and $\frac{1}{5}$" thick, weighs 2 grams and upon total decomposition yields 1 gram of gaseous phosphine. The residue of aluminum hydroxide is almost completely decomposed when the grain is moved, and it is entirely removed by the handling and turning that accompanies further processing of the grain.

In our investigations, we used Phostoxin experimentally to treat 60,000 bushels of wheat stored in a Manitoba country elevator. Test conditions were rather severe in that the grain temperature ranged from 40°F. to 65°F. and strong winds persisted throughout the fumigation period. This product is recommended for use at grain temperatures of 54°F. or higher, the exposure period decreasing from 5 days at 54°F. to a minimum of 3 days at 69°F. or over.

In our experiment, insect test cages and gas sampling tubes were suspended at 4 levels throughout

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Remains of tablets following decomposition and release of phosphine gas. (Note dead insects on floor.)

the depth of the empty bins which were to receive the fumigated wheat. In this manner we could correlate insect mortality with fumigant concentration at the various levels.

We calculated the number of Phostoxin tablets required for each bin of wheat on the basis of varying dosages from the commercially recommended rate of 6 tablets per ton down to 1.6 tablets per ton. We added the tablets to the wheat in equal lots at 10-minute intervals during the turning operation. Farm-stored grain could be similarly treated by adding the tablets to the grain as it was being augered into the storage bin.

In this investigation, we took a series of wheat samples prior to adding the fumigant and again as the wheat was turned following fumigation. The post fumigation samples were submitted to the Board of Grain Commissioners' Inspection Branch for official grading and to the Grain Research Laboratory for milling and baking tests.

We collected gas samples from the various levels in each bin every day for 4 days and had them analyzed for concentration of phosphine. We made insect mortality counts when the grain was moved and the test cages could be removed.

Our investigations carried out in a Manitoba country elevator showed that a 4-day exposure period at a dosage of 3.2 tablets per ton of wheat would give 100 per cent mortality of the test insects. The recommended dosage of 6 tablets per ton resulted in some insect survival at the lower levels in the bin. These results were probably due in part to the average temperature of the grain dosed at 3.2 tablets per ton being 63.8°F., while the average temperature of the grain dosed at 6 tablets per ton was only 51.8°F.

Our studies also revealed that wheat samples which had been collected following a single turning of the grain were down-graded by the Grain Inspection Branch on the basis of foreign odor, but samples collected following a second turning of the fumigated wheat were free of odor. Milling and baking tests indicated that no deleterious effects were imparted to the wheat by the fumigant.

Additional testing of this product under various environmental conditions remains to be done, but I believe Phostoxin will be a valuable addition to the list of effective fumigants for the control of insects in stored grain.

New method used to sample fumigated grain for presence of phosphine. Blackened portion of tube indicates concentration of gas present.

Garland apples in September.

APPLES.

J. W

HARDINESS OR RESISTANCE to extreme cold and drought is the prime requisite in apples for the prairies. Our breeding and testing program at Morden has progressed in four stages:

1. Selecting the best open-pollinated seedlings of the hardiest varieties sent from the Central Experimental Farm, Ottawa, in 1916. Several varieties, *e.g.* Mantet, Breakey, and Goodland were named.

2. Hybridizing hardy crabs with apples and the selection of the so-called apple-crabs. The variety Kerr is an outstanding example.

3. Crossing apple-crabs and large apples. Some selections from this program are now under final testing, *e.g.* McIntosh×Trail.

4. Crossing large-fruited varieties, and retaining hybrids with large fruit and hardiness. Carroll and Garland are considered reasonably hardy although they have not been subjected to a severe test-winter.

Other characteristics we have considered in the selection program are quality, disease and pest resistance, earliness of fruit maturity, and yield. We have found that prairie varieties kept in storage are not as good eating as winter apples shipped from other areas of

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Garland (M364) apples are highly colored and of good size.

Unpolished apples of variety Carroll (M366) showing good size and characteristic bloom.

For the Prairies

The apple-crab Kerr is productive, hardy and good tasting.

ison

Canada, but in the fall, and especially at picking time, some of the Prairie apples have no equal. Our studies have shown that disease resistance is not vital although fireblight has ravaged some orchards and scab was bad in 1962. Aphids, mites, cankerworm, and other insects can be controlled with suitable sprays. Most of the recommended apple varieties mature fruit in sufficient time to escape fall frosts. Yield, an important feature of any crop, is probably affected to a greater extent by moisture supply than by hereditary features. Most trees are grown under clean cultivation but if fruit growers have water available, moisture should not be limiting.

The varieties Carroll and Garland, were recently released by the Morden Experimental Farm, where they have been tested at Morden for over 20 years. We have found that they show abundant hardiness and productiveness: Carroll ripens in late August to early September, and Garland in late September. Each bears medium sized to large fruits which are highly colored and attractive. They rate high for cooking and for dessert.

The Morden Farm maintains a foundation stock of these varieties but trees for general use should be obtained from nurserymen in Manitoba or in the other provinces.

The apple-crab Kerr is a good yielder (fruit from one tree).

Picking crabapples from tree protected by field shelterbelt.

Scotland Yard of Cereal Breeding . . .

Detective Work on Wheat

E. R. Kerber

The author delves into the origin of wheat and tells of a new approach being investigated at Winnipeg in determining characteristics, recounting developments that illustrate the importance of basic research in preparing the ground for practical advances.

RESEARCH in Canada and other countries has now provided us with a reasonably accurate picture of the origin and evolution of the various species of wheat belonging to the genus *Triticum*. Botanical studies have shown the relationships among the three specific groups within the genus and the order in which they evolved. Supporting evidence has been found on examining the remains of wheat discovered in archaeological excavations. The information thus obtained is of fundamental importance since it provides leads for the development of improved varieties of cultivated wheats.

All species of wheat fall into three natural groups based on the number of hereditary bodies in the cells—the chromosomes. Seven is the basic number for wheats, since the total number of chromosomes is always a multiple of seven. The oldest and most primitive group, the diploids, has seven pairs of chromosomes or a total of 14. This whole set of seven pairs is termed the A genome. A present-day representative of this group is einkorn (*T. monococcum*), still grown on small acreages in Europe and the Middle East.

The second group of wheats has 14 pairs of chromosomes or a total of 28. These are composed of the same set of seven pairs found in the diploid group plus another set of seven pairs, distinct from the A set, called the B genome. All wheats belonging to the second group are termed tetraploids since the number of chromosomes is a multiple of four. This group originated in pre-historic times through a cross between the diploid group, contributing the A genome, and a wild non-wheat grass contributing the B genome. This grass is believed to be *Aegilops speltoides* or a closely related ancestor. At the present time durum wheat, a more recently evolved type, is the only member of the tetraploid group that is of commercial importance.

The third and most recently evolved group of wheats is the one to which common bread wheat belongs. All members of this group have 21 pairs or a total of 42 chromosomes. These consist of the 14 pairs from the tetraploid group, that is the A and B genomes, and a third set of seven pairs, the D genome. All wheats belonging to this group are called hexaploids since the total number of chromosomes is a multiple of six.

The hexaploid group originated through crossing between the tetraploid group (A and B genomes) and *Aegilops squarrosa*. This last species, belonging to the same genus as the supposed source of the B genome, has provided the D genome with seven pairs of chromosomes. *Ae. squarrosa* is a weedy grass still found growing in wheat fields from southeastern Europe to Afghanistan.

Present-day descendants of the three ancestors of common wheat. *Left to right:* Einkorn, *Aegilops speltoides*, *Aegilops squarrosa*.

Dr. Kerber is a cytologist with the CDA Research Station, Winnipeg, Man.

Studies on the origin of wheat have led to the identification and geographic location of the ancestors of common bread wheat and of their present-day descendants. These descendants and related grasses are of practical value as a source of desirable agronomic and other characteristics that can be transferred to commercially grown varieties of wheat. This is particularly true of disease resistance. For example, at the Research Station in Winnipeg the stem rust resistance of certain Ethiopian tetraploid wheats has been transferred to common wheat. Conversely, the stem rust resistance of a bread wheat obtained from Kenya has been transferred to commercial drum wheat varieties which are tetraploids. We have also successfully transferred early maturity and short, strong straw from the highly improved bread wheat varieties Selkirk and Canthatch to the commercial durum wheat varieties Stewart and Mindum which lack these desirable characteristics.

New Approach

Looking to the future, a new approach is being investigated at Winnipeg in an attempt to determine more precisely the characteristics of the three genomic components of hexaploid wheat, including varieties of common bread wheat. We are attempting to separate hexaploid wheat into the component species that originally combined during the course of evolution, as already outlined. Briefly, the method used to extract the tetraploid portion (A B genomes) of common hexaploid wheat is to first cross it with a tetraploid such as durum wheat. This is followed by seven consecutive backcrosses to the particular common wheat variety being used. The objective is to remove the hereditary factors contributed by the durum wheat and at the same time produce what is called a pentaploid plant. This type would have the complete sets of the A and B genomes (28 chromosomes) of the common wheat variety but only seven of the D genome chromosomes rather than 14. Upon selfing this pentaploid, a 28-chromosome type is obtained, among other kinds, that represents the tetraploid component (A and B genomes) of common wheat.

So far we have succeeded in extracting the tetraploid portion of the commercial bread wheat variety Canthatch. This tetraploid differs strikingly from commonly known varieties of the tetraploid group of species. The plant is semi-dwarf with spikes that are very short and compact, resembling in these respects club wheat, a hexaploid type. Less than 50 per cent of the florets produce seed.

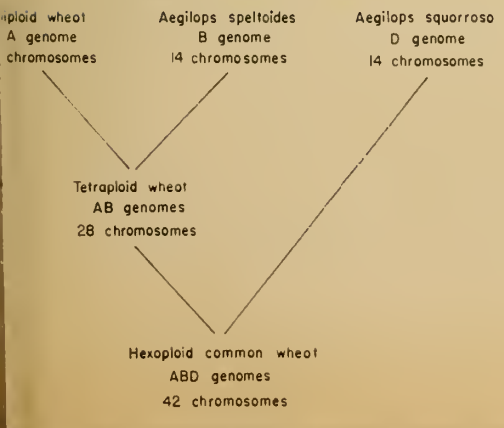
We might account for the absence of a present-day tetraploid wheat that resembles the tetraploid component of Canthatch by assuming that the ancient tetraploid parent of common bread wheat is extinct or yet to be discovered. On the other hand, we can also hypothesize that since becoming a part of common wheat, the tetraploid component has diverged along an evolutionary path different from that of other tetraploids such as the emmers and durum wheat.

We have also duplicated the final step in the evolution of hexaploid wheat and confirmed that *Ae. squarrosa* contributed the D set of seven chromosomes. This was done by crossing the tetraploid (A B genomes) extracted from Canthatch with a strain of *Ae. squarrosa* (D genome). The hexaploid obtained from this hybrid is very similar to bread wheat except that the kernels are hulled.

The extracted tetraploid component of common wheat varieties has potential value in both durum and common wheat breeding. It makes possible the transfer from common to durum wheat desirable characteristics that are determined by hereditary factors on the A and B genomes. This procedure avoids the complications that ordinarily result when common and durum wheat are crossed. Moreover, the extracted tetraploid component is valuable in breeding common bread wheat because of the synthetic hexaploids that can be readily produced by combining it with *Ae. squarrosa*. For example, it is now possible to evaluate different strains of *Ae. squarrosa* when they are combined with the tetraploid component extracted from improved common wheat varieties. Preliminary results show that the agronomic characteristics and other qualities of such synthetic hexaploids cannot be predicted from those possessed by the tetraploid and *Ae. squarrosa* parents; the process is not merely additive, so to speak, but involves what we may call combining ability.

These developments illustrate the importance of basic research in preparing the ground for practical advances. First we have the painstaking studies of the numbers and behavior of the microscopic chromosomes in the cells of different wheat species and related grasses. From these we learn of their relationships and probable evolution. Verification of our hypothesis is provided by archaeological studies. The idea of taking apart the complex common bread wheat varieties then occurs. Now that this has been shown to be possible, we have new materials for our breeding programs. New paths have thus been uncovered leading towards our principal objective: the development of better wheat varieties for Canadian farmers.

Origin of common wheat.



Canthatch common wheat (left) and extracted tetraploid component (AB genomes) of Canthatch (right).

Predacious insect attacking a codling moth larva.

Integrated Insect Pest Control

An example of how it has been successfully applied to the codling moth in Nova Scotia

C. R. MacLellan

THE VALUE OF an integrated pest control program may be grasped by the fact that in 1948, when chemical control was in full swing, 31 per cent of the fruit in Nova Scotia's Annapolis Valley was damaged by the codling moth but in 1961, under an integrated program, the damage was only 1.7 per cent. An integrated program simply is one that makes the best possible compromise between chemical and natural control so that the one complements the other.

With highly efficient machinery for applying pesticides and a seemingly endless stream of powerful insecticides available it might be expected that chemical control of insect pests would now be a minor problem. In our investigations at Kentville, this is certainly not the case with tree fruit insects, particularly the codling moth, hence our interest in natural controls. Natural control and control by chemical means are not necessarily alternative methods but with adequate understanding they may be integrated to supplement one another.

We have found that the numbers of codling moth in Nova Scotia fluctuate around an economically tolerable threshold. Should an upward trend occur, say by the failure of natural enemies, chemical spray materials may be necessary. In an integrated program, our studies showed that a situation of this kind would call for an insecticide that is highly toxic to the codling moth and harmless to its natural enemies. Unfortunately, we do not yet have materials with all these characteristics but the botanical insecticide ryania has many of the desirable qualities. In our investigations, we found that it is highly toxic to the codling moth and only slightly damaging to the complex of natural enemies. When ryania came into general use in

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Left: Parasitized egg showing blackened chorion. ***Center:*** Eggs preyed upon showing wrinkled eggshell. ***Right:*** Embryonic remains (darkened area).

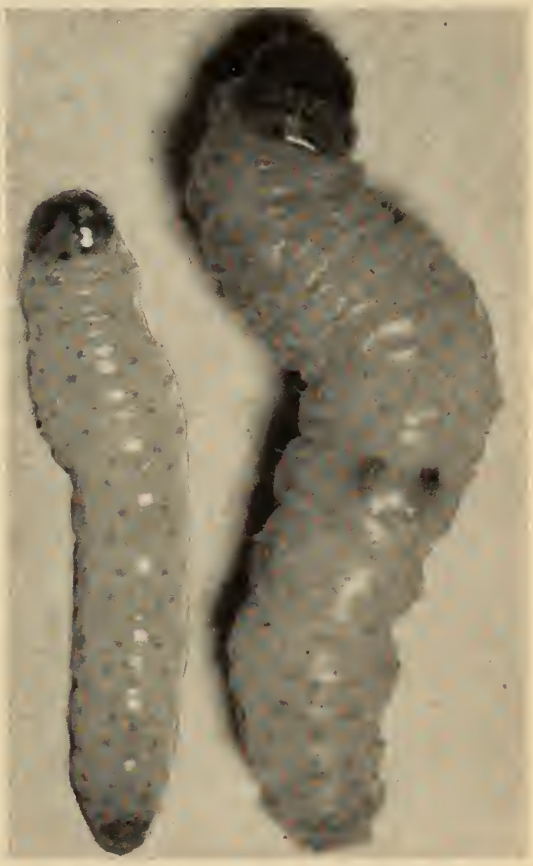
Nova Scotia in 1954 the codling moth was quickly reduced to an economically tolerable level and the extensive population fluctuations which follow the use of wide spectrum insecticides, such as DDT, did not occur.

Many farmers do not realize the benefits that can be gained by protecting and otherwise aiding natural enemies. Our studies in a commercial orchard subjected to an integrated control program since 1950 have shown what can be accomplished by natural control. During the 12 years of the program, insecticides were used on only seven occasions against such pests as the eye-spotted bud moth, tent caterpillars, the fall cankerworm, the winter moth, and a plant-feeding bug. No insecticides were used against the codling moth which reached peak numbers in the orchard in 1951. Damage to fruit in that year amounted to 18.3 per cent but since then the infestation has gradually diminished until in 1961 the damage declined to a low of 1.3 per cent.

Our studies revealed that, from egg to adult, the codling moth is vulnerable to several natural control agents. We found that the egg stage is attacked by parasites and insect predators which may kill as many as 20 to 25 per cent of the eggs. Mortality of newly hatched larvae due to predation and other natural causes such as drenching rains and high winds may reach as high as 50 to 60 per cent. Predation of overwintering (mature) larvae by woodpeckers and insects, fungal and insect parasitism, and mortality by low winter temperatures may reach as high as 95 per cent. Unknown and variable amounts of predation occur in the pupal and adult stages as well. Our studies have pointed up the importance of natural control agents. This importance can hardly be overestimated and, furthermore, the agents should be protected wherever possible.

In the Annapolis Valley during the past eight years, we have, as a result of our investigations, recommended that growers whose apples showed damage from codling moth above the tolerable economic threshold should use ryania beginning about 14 days after petal fall, and one or two additional applications, if needed, at from seven- to ten-day intervals. These treatments have proven satisfactory and their use has not been attended by the violent fluctuation of pest populations that follow the use of the synthetic organic insecticides. Because of the effective assistance rendered by natural controls, we have found that it has been necessary, in some orchards, only to apply ryania at intervals of two to four years. In addition to the excellent control of the codling moth which is obtained by ryania, we discovered that the numbers of the eye-spotted bud moth as well as some other pests have dropped to low levels. Also because natural control agents are not interfered with, sprays are no longer needed for the European red mite or the oystershell scale and the number of spray applications for aphids and other pests has been greatly reduced.

Above: **Hatched egg and fresh entry in fruit.** *Below:* **Mature larvae; healthy male (left), parasitized larva (right).**



From the left: **Mature larva and cocoon on bark of tree. Adult on fruit. Codling moth stings on fruit.**

Left: Field roughly leveled for border-dyke irrigation. Grid stakes are not disturbed until leveling completed. *Inset:* Scraper leveling on land proposed for irrigation. *Below:* Irrigating newly leveled land on Pre-development Farm at Outlook, Sask., using border-dyke system.

Land Leveling for Irrigation

E. Rapp

LAND LEVELING, for irrigation purposes, involves the movement of earth over distances of several hundred feet to modify the surface relief for more efficient irrigation. This should not be confused with land planing, land smoothing, or floating which requires special equipment to eliminate minor irregularities and does not change the general topography.

A land-leveling program was initiated on the Bow River Irrigation Project in 1955, after a study of 12 typical farms of the Hays and Vauxhall areas had revealed that irrigation efficiencies were very low—about 20 per cent. Most farmers were only able to give a crop 1 heavy application of water instead of 2 or 3 lighter, timely irrigations during the season.

Proper land preparation is the key to improved irrigation efficiency. Before 1955, heavy earth-moving on the Bow River Irrigation Project was usually done 'by eye' without an adequate leveling plan. But since then, when PFRA undertook to level land at cost for any farmer on the Project who wished it, all fields were surveyed and a proper leveling and distribu-

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tion plan prepared. In the first two years of the program, 1,600 acres were leveled for 38 farmers. Although financial assistance for leveling has not been available since 1956, still 5,000 acres have been leveled to date on the Bow River Project, including some 2,000 acres of government land.

In this Project all fields, with a few exceptions, were designed for the border-dyke method of irrigation. It gives excellent water control, enables an irrigator to handle large streams, and eliminates ditches within the field. The major requirement is that a field be properly leveled and planed. Although few farmers have adopted the border-dyke method, it has been used exclusively on PFRA pasture lands. This layout provides a very satisfactory plan regardless of the method of irrigation used.

Most of the land leveling on the Bow River Project has been done on an hourly basis at commercial rates. However, some experienced dirt movers are now contracting land leveling on a yardage basis. Our costs on the Project have ranged from 12 to 35 cents per yard depending on soil type and conditions, the degree of finish, the amount of topsoil replaced, the type and cost of equipment, and the experience of the equipment operator.

The most immediate benefit of the land leveling program has been the saving of irrigating time and labor. Most farmers report that they can irrigate 2 to 3 times as much land as previously, using the same head of water. This varies from 5 to 20 acres a day depending on the water applied, moisture conditions before irrigating, the crop, soil type, and the land slope. An irrigator can apply water much easier on leveled land and often it is possible to handle extra heads of water on other fields.

Improved water management has resulted in some yield responses after leveling. Over half the farmers have reported normal yields and some who have done heavy leveling reported 25 to 40 per cent increases in yields. This can be attributed to the fact that the high spots had previously suffered from drought and the low spots drowned out. After leveling, a more uniform application was possible.

Heavy land leveling has often been opposed and criticized because it disturbs the topsoil, and because the cost of large-scale stock-piling of topsoil is prohibitive. However, we have found the "trench" or "strip" method of saving topsoil satisfactory. In this operation, we cut strips or trenches below grade throughout a cut area and later borrow topsoil from adjacent untouched strips to bring the area to grade. There is some mixing of topsoil and subsoil but it does avoid complete removal of all topsoil from any portion of the field. Extra cost varies with the soil profile and amount of leveling. We found, in one cost study, that 9 per cent of the total area required topsoil saving and cost $8.15 per acre or 12.6 per cent of the total cost of leveling. Our studies also revealed that these areas can be brought into full production by plowing under green manure crops or making large applications of manure to the unproductive areas, plus commercial fertilizer. Many farmers who have followed one or more fertility improvement practices on the cut areas have reported 80 to 100 per cent of normal production within 3 to 4 years.

The increasing demand for land leveling in southern Alberta is evidence that it is highly profitable from a farmer's point of view. We have found that the farmers' standards of leveling go up from year to year. This makes it desirable to design as refined a job as the soil will permit and the farmer will accept and pay for. Before a farmer decides to land-level, he should consult his district irrigationist or district agriculturist on developing a suitable plan. In special cases, this technical assistance is also available from the CDA Research Branch, or the PFRA office in the district.

Land plane in operation on field being developed for irrigation near Taber, Alta. Land planing, which differs from leveling, does not change the general topography.

Abundant Forage on Solonetz Soil

R. R. Cairns

We reported in an earlier issue (*RfF, Summer, 1961*) that research work conducted on the Soils Research Sub-Station at Vegreville, Alta. had shown the lack of available nitrogen to be a major factor limiting the productivity of crops grown on Solonetz soil. Since that article was written we have obtained new evidence on (1) the effect of nitrogen fertilization on the yield and chemical composition of the forage crops, and (2) the effect of stimulated crop production on the chemical and physical properties of the soil.

(1) Effect of nitrogen fertilization on yield and chemical composition of forage crops.

In 1961 we had a relatively poor year for hay production. Established but unfertilized brome sod produced slightly over 1 ton of dry matter per acre, while areas fertilized in the spring with 800 lb. of ammonium nitrate (33.5-0-0) yielded over 2½ tons. The dry spring of 1961 limited the effectiveness of the 800-lb. application to the extent that no profit was realized. We applied the same treatments again in 1962 which was a more favorable year for forage production. This time yields increased from an average of 2.2 tons of dry matter per acre on the unfertilized areas to 8.3 tons on those fertilized with 800 lb. of ammonium nitrate. The 800-lb. application brought a profit of over $30 an acre. Lower rates of application showed substantial but lesser profits. Neither the application of phosphorus nor the use of irrigation stimulated production in either year in spite of the moisture deficiency that prevailed in the early summer of 1961.

In our investigations, we found that the chemical composition of the fertilized crops changed drastically. It tended to be 'normalized' by fertilization and more closely resembled that of bromegrass grown on naturally productive Solodic soil.

Fertilization significantly lowered the sodium, silicon, aluminum, iron, sulphur, copper, and manganese content of the crop and greatly increased the nitrogen and potassium content. It increased the proportion of calcium to magnesium and boosted the carotene content more than three-fold. The crop grown on unfertilized Solonetz soil consistently contained more inert ash residue than the fertilized one grown on Solodic soil. We are continuing our studies on the composition of this inert residue and what effect 'created changes' in the supply of various nutrients have on greenhouse productivity of both Solonetz and Solodic soils. We want to determine if some nutritional factor is limiting productivity and causing the nitrogen problem of Solonetz soil.

(2) Effect of stimulated crop production on chemical and physical properties of the soil.

In this study, we found that the fertilized crop removed moisture to a greater depth than the unfertilized crop, and the soil under the heavy crop of hay mellowed and became more permeable. We also discovered some slight indication that salts may have retreated from the upper soil horizons. This is a long-term study, of course, but the slight evidence obtained to date gives some hope that the production of abundant forage will lead to permanent soil improvement.

We have extended this study to seven of the major Solonetzic soil types in the Black and Dark Brown soil zones of Alberta. Indications from our research in the greenhouse are that results should be applicable, but such local factors as precipitation, the kind and quantity of salts, and the soil depth at which they occur might limit crop response. In the meantime, it is suggested that farmers on Solonetzic soils should test the effect of applying between 200 lb. and 400 lb. of ammonium nitrate per acre or equivalent quantities of other nitrogen fertilizers. Rates above 400 lb. are not suggested until we have further studied such factors as possible nitrate toxicity to livestock.

It is important that water be prevented from accumulating on the surface of these soils. They are naturally very impervious and the presence of surface water, besides killing out the crop, tends to elevate the salts in the soil. The stimulation of crop growth helps alleviate this problem by increasing water penetration and use. But severe and continued flooding will kill off the crop and harm the soil.

Bromegrass (left) not fertilized with nitrogen and treated plot (right). Application was 800 lb. per acre of 33.5-0-0.

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